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Supporting Critical Thinking with Critiquing Systems in Military C2 Environments

Decision Making and Cognitive Analysis

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Abstract

There is a growing interest for the integration of critical thinking, defined as the capacity of thinking about one's own reasoning, into military practices. In this paper, we discuss the potential of critiquing systems (critics) – software programs that provide a critique of the user-generated solution – for training critical thinking skills.
More specifically, we discuss the use of two types of critics, generic and experiential, which respectively use doctrine-related and case-related knowledge. The generic critic applies general knowledge about standard practices, while the experiential critic makes the practitioner consider distributional data, as provided by case bases and lessons learned. This paper discusses the type of issues that can thus be addressed.

1. Introduction

The aim of the present paper is to show the usefulness of critiquing systems (critics) for supporting critical reasoning in the military context. We argue here that these advisory systems can, on the one hand, provide generic critiques that would remind the user of general doctrine-related knowledge, and on the other hand, bring him, by means of experiential critics, to consider relevant knowledge retrieved from similar cases and lessons learned.

The paper is organized as follows: first, we outline the principles of critical thinking as discussed in relevant literature (Section 2), and then we compare the dynamics of collaborative criticism dialogues in the human-critic setting with the internalized dialogue of critical reasoning (Section 3). In Section 4, we discuss the type of judgment biases that the use of critics can correct. Next, we show how generic critics can guide the user in his problem solving process by reminding him of relevant issues and factors (Section 5) and how the experiential critic, using case-based reasoning and lessons learned, can make the user consider or learn from previously experienced cases (Section 6).

2. Critical thinking

The subject of critical thinking has been studied for years (e.g. in philosophy, psychology, education) and has recently gained importance in the military domain, in particular for training military decision-makers dealing with complex and knowledge-intensive tasks. Challenges that face military decision-makers, in the context of increasing complexity, changing character of military operations, information overload, increased responsibilities and initiatives, reinforce the usefulness of thinking critically.

The roots of critical thinking are as ancient as the vision of Socrates, known as "Socratic questioning", who established the importance of asking deep questions that probe profoundly into thinking before we accept ideas as worthy of belief. He established the importance of seeking evidence, closely examining reasoning and assumptions, analyzing basic concepts, and tracing out implications not only of what is said but of what is done as well. In his mode of questioning, Socrates highlighted the need in thinking for clarity and logical consistency [1]. Later, the military strategist Carl von Clausewitz also promoted the value of critical thinking for strategic leaders in his writings [2].

Several definitions of critical thinking have been developed by contemporary theorists that highlight self-examination of thinking. Freeley and Steinberg [3] define critical thinking as "the ability to analyze, criticize, and advocate ideas; to reason inductively and deductively; and to reach factual or judgmental conclusions based on sound inferences drawn from unambiguous statements of knowledge or belief". A critical thinking attitude involves asking questions, defining a problem, examining evidence, analyzing assumptions and biases, avoiding oversimplification, considering other interpretations, and tolerating ambiguity.

Thinking, to be critical, must be analyzed and assessed according to intellectual standards and criteria, such as clarity, accuracy, relevance, depth, breadth, and logicalness. The process of thinking critically entails the examination of elements of thought implicit in all reasoning: purpose, problem or question at issue, assumptions, concepts, empirical grounding, reasoning leading to conclusions, implications and consequences, objections from alternative viewpoints, and frame of reference [4]. From these elements, Col. Guillot [5] highlights some thinking skills that are particularly relevant in the military context. A military strategist must assess if his purpose is in line with goals and needs, look at situations from multiple points of view, change focus and shift his thinking to see things differently.

Halpern [6] presents critical thinking as a goal-directed process as it focuses on desired outcome. Cohen [7] also conceives of critical thinking as a dialogue that explores alternative possibilities under the constraints of context-specific goals. He describes critical thinking skill as 'asking and answering critical questions about alternative possible state of affairs, to the extent that such questioning is likely to increase the reliability of the overall activity in achieving its purpose'.

Critical thinking can be introduced in the military decision making realm for different purposes (situation assessment, mission analysis, operation planning, etc.). However, there are good reasons to believe that decision makers will not engage in critical scrutiny of their decisions and plans under stressful and time-pressed conditions. In attempts to obtain the degree of knowledge needed to anticipate alternative outcomes, the decision-maker is likely to be overwhelmed by 'information inundation', which can be quite as incapacitating as the lack of information. Ill-structured problems, uncertainty, shifting goals, action/feedback loops, time stress, high stakes and multiple players are other factors [8] that affect decision making performance in contexts such as the military environment. Because of all these difficulties, adopting a normative decision making approach would already place huge demands on decision makers' resources and mental capabilities. Adopting a critical attitude would be an even greater challenge.

Our contention is that critical thinking skills can be inculcated to decision makers, by the use of critiquing systems during training sessions, and that this exercise will eventually lead to better decision making in real situations of analysis, evaluation and planning.

3. Dialogues with critiquing systems

Critiquing systems are a class of program that receive as input the statement of the problem and the user-proposed solution and produce as output a critique of the user's judgment and knowledge [9]. The feedback (criticism) output to the user may report errors, point out incompleteness, suggest alternatives, or offer heuristic advice. As such, critiquing systems present a great potential for supporting critical reasoning.

These advisory systems exemplify the dynamics of critical discussions in which a proponent defends a claim against challenges of various kinds by an opponent or critic [10]. This type of interaction, be it in a human-human or human-system setting, is a promising framework for supporting critical thinking, primarily because of the 'functional similarity between rationally persuading another individual to accept or reject a position, and rationally determining for oneself whether a position is acceptable or not' [11].

The internalized dialogue of critical thinking where the same person embodies two distinct participants, can be transposed to the critiquing systems' paradigm, viewed as a 'mutual exchange of viewpoints between the expert human and the expert critic' [12]. Fischer et al. [13] define the interaction with a critiquing system as 'a dialogue in which the interjection of a reasoned opinion about a product or action triggers further reflection on or changes to the artefact being designed'.

During the criticism dialogues, the user constructs partial solutions that the critic evaluates with respect to a set of criteria and constraints. The output, signaling errors and deficiencies, feeds back into the user's mental model and results in elaboration or modification of certain elements. The system thus helps the user validate a body of knowledge through a collaborative dialogue with the aim of improving the product and enhancing the quality of decision making. Criticism dialogues have many positive

outcomes such as error elimination, deeper reflection, better situation analysis, and growth of knowledge [13].

4. Errors and Biases

Competency in critical thinking helps individuals to distinguish fact from judgment or belief from knowledge. One of the main objectives of critiquing systems is to prevent or correct erroneous decision making due to lack or misuse of knowledge, poor heuristics or judgment biases [14].

In [14], Silverman presents an error model which accounts for: (1) errors in the expert's knowledge base due to missing concept or missing knowledge, and (2) errors in the expert's reasoning processes due to cognitive bias or systematic selection of poor judgement heuristics.

Reason [15] refers to the same categories of errors as knowledge-based and rule-based mistakes. For Reason, knowledge-based mistakes have their roots in two aspects of human cognition: bounded rationality and the fact that knowledge relevant to the problem space is nearly always incomplete and often inaccurate. Rule-based mistakes, on the other hand, are either due to misapplication of good rules or to the application of bad rules. Reason associates these mistakes to problem solvers' habit of pattern-matching. If a pattern is recognized and some kind of match is performed, a previously established if (condition) then (action) rule-based solution is applied. Only when this procedure fails to provide an adequate solution, will they move to the mode of making inferences from knowledge-based mental models of the problem space. With his Recognition-Primed Decision Model, Klein [16] shows that this type of decision making prevails in time-compressed environments. Experienced people make rapid decisions using situation assessment to generate a workable course of action and mental simulation to evaluate that course of action.

Although these early judgments about a problem help decision makers to save time, reduce complexity and rapidly generate partial solutions, they are often based on informal reasoning. Silverman talks of mental myopia due to force of habit, selective perception, and availability biases [14]. He gives examples of this in the domain of Army forecasting: for army forecasters, past examples of degradation and damage from threats they encountered and studied in their own discipline are the most vivid and easy to recall. For example, attack helicopter specialists most vividly visualize potential damage from enemy attack helicopters and not the damage resulting from encounters with other threats.

Unaware of their judgment biases, problem solvers and planners tend to be overconfident in evaluating the correctness of their knowledge. They will tend to justify their chosen course of action by focusing on evidence that favors it and by disregarding contradictory signs. Also known as the confirmation bias, this strategy consists of seeking information consistent with current beliefs and avoiding falsifying evidence.

In their study on critical reasoning biases, Klaczynski et al. [17] also show that when presented with pertinent information, individuals apply a wide range of reasoning tactics to preserve the integrity of their goals and beliefs. They readily assimilate belief-enhancing information without engaging in critical scrutiny, but they engage in extensive data analysis and deep processing when facing belief-threatening information. The use of sophisticated strategies in the latter case can result in refutation of the data.

For Silverman, the role of the critic in this context is to draw the practitioner's attention to two categories of knowledge that are critical to successful task outcomes. This includes 'overlooked knowledge' that the human ignores for reasons of biased judgment and 'missing knowledge' that the practitioner is unaware of due to incomplete or out-of-date training.

We will argue here that in the C2 domain, the critiquing system can intervene by providing general doctrine-related knowledge that the practitioner 'normally masters but has neglected to apply' [12], as well as experiential knowledge that is based on other individuals' experiences and observations and which are either unknown to the user or are not accessible during his problem solving task.

5. Use of doctrine-related knowledge for critiquing

A critiquing system can have 'generic critics' that provide general knowledge about standard practices and 'experiential critics' that relate the current problem solving situation to past experiences and lessons learned.

The generic critic, following what is traditionally called the analytic approach to critiquing, can walk the user through his problem solving task by reminding him of certain rules, criteria and constraints. Such a critic detects error occurrences or deficiencies that it then turns into assistance opportunities [18]. It relies on the user's proposed plan of action sequences (or focus of attention) as a basis for the generation of critiques and the critiques it formulates are based on domain knowledge.

A generic critic can check whether certain procedures have been correctly followed (e.g. Operation Planning Procedure), whether the requirements formulated have been met (e.g. Mission Order) and whether mandatory constraints for the achievement of specified goals are fulfilled.

Within the analytic framework, critics do not need to have a complete understanding of the product. Because their role is not to offer a solution, but to check the user's partial solution for flaws, these critics are well-suited for vague and ill-defined problem domains where they can provide support by applying general knowledge. In fact, critiquing systems using this mechanism can be very successful in application domains in which problem solving is performed on a constraint-satisfaction basis. Miller [19], who was the first researcher to see a great potential in the use of critiquing systems for decision support observed that critiquing systems are most appropriate for tasks that require that

the practitioner remember or consider a lot of information such as the procedures, risks, benefits, side effects and costs.

Thus, in high-level tasks of decision making and planning, the generic critic can help the user test different options against a whole array of requirements and constraints. In such sufficiently structured framework, critics can check that the norms and standards have been respected, that there are no obvious inconsistencies or errors and that problematic conditions do not hold.

Most of the military applications of critiquing systems use this critiquing procedure to perform COA evaluation and planning. As part of the HPKB and RKF DARPA programs, whose primary objectives were to provide tools facilitating the building of large knowledge based systems by domain experts, a number of COA critiquing systems were conceived that make use of knowledge input by subject matter experts as well as ontologies (common domain theories) on planning. SHAKEN uses a set of rules input by subject matter experts to control the user's action and enables him to simulate a COA in order to evaluate its performance [20]. Disciple-COA is another critiquing tool which uses previously learned rules (from examples provided by experts) to assess the viability and correctness of a course of action, highlight its strengths and the weaknesses with respect to principles of war and tenets of army operations, justify the assessments made and propose improvements to the COA [21, 22]. Inspect [23] is an evaluation tool that checks the consistency of air campaign plans (completeness, feasibility) and alerts the user about inconsistencies and potential problems. In the collaborative decision making context of ROLF 2010 [24] (C2 system research project conducted by the Swedish National Defense College), the critiquing system provides feedback on the effects of staff members' plans on each other's intentions.

The only military application aimed at critical thinking training that we know of is a simulation tool proposed by Cohen and Shastri [25]. A connectionist network is used to model rapid *reflexive processes* (rapid generation of coherent interpretations and plans) and the *reflective processes* that monitor and regulate them.

Less ambitiously, we think that critiquing systems can use different intervention strategies (proactive, reactive) to trigger further reflection on the different elements that lead to a given decision. In [26], Silverman emphasizes the role of preventive critics which can warn experts about nonregressive and overconfidence biases and explain how to avoid them. Placed before the task, these 'influencers' divulge common errors and remind the user of the kind of decisions that are expected before the user begins the problem solving process.

For example, at the strategic/operational level, critics can bring the decision maker to question some of the main issues which will guide further actions. This can be done by means of leading question asking. Following the different steps in decision analysis process, the critic can make the decision maker verify whether the problem has been correctly identified, that he is pursuing the right objectives and that they have been clearly articulated, that all the options have been considered, that the criteria used to

evaluate them are indeed the most relevant, that the implementation of an option does not imply undesired consequences.

As Col. Guillot [5] writes, “the critical thinker must ask: what is my real *purpose*, what is the *key issue*, what is the most relevant *information*, what are the correct *concepts* in this case, are my *assumptions* valid, have I drawn the correct *inferences*, what *points of view* matter, and what are my desired *implications*?” Illustrating the fourth point, he rightly observes that one of the lessons learned after September 11 is that an aircraft can be used as a flying weapon. ‘On that day the concept of ‘a missile’ or ‘bomb’ changed and so did our idea of how to protect against such a conceptual shift’. Our conceptual model can undergo less radical yet decisive changes when confronted with belief-threatening information.

Critiquing systems can exploit intelligence data sources to present possibilities that the decision maker had not foreseen. Such influencing strategies can be complemented by persuasive techniques such as explanation and argumentation. We think that the critiquing system must also account for cases where the user himself takes the initiative of submitting his opinion to critical scrutiny. This can be a request for a punctual evaluation or, as we later discuss, a demand for presentation of cases with similar problems or problem elements.

Criticism dialogues can be more efficient if carried out by a critic than by oneself, because the system can present more problem solving approaches that one can possibly think of. Also, system-generated critiques run a smaller risk of being rejected since as Fischer et al. [27] point out, critiques coming from an intelligent computer assistant might be more tolerable than critiquing from a human, because they are handled as a private matter between the user and the computer. The other advantages are related to the training context. First, the user will be less bothered by the intrusiveness of critics in this setting. Second, in a learning position, the practitioner will tend to be more open to other perspectives and will not resort to heuristics, which are normally used for reasons of time, habit, stress, or perceived efficiency. Finally, he will probably tend to evaluate data independently from his personal goals and beliefs, which as Klaczynski *et al.* [17] have claimed, are indispensable for effective critical thinking.

6. Use of experiential knowledge for critiquing

‘Critical thinking is the intellectually disciplined process of processing information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action’ [4]. From this perspective, critical reasoning consists, at least in part, of considering acquired experiences and observations and relating them to the current problem solving situation.

In his attempt to correct judgment biases by means of critiquing systems, Silverman also observes that the critic must help decision makers regress to distributional data (Kahneman and Tversky [28]), which is knowledge about the distribution of outcomes in similar situations.

Experiential critics can fulfill this requirement by relating the user's decision situation to similar cases experienced by his co-workers. When dealing with complex and knowledge-intensive problems where the problem-solving process requires exploring a large problem space, and when this problem solving environment is not time-constrained, it may be beneficial for decision-makers to learn from others' experiences in addition to relying on their own memory. The analysis and interpretation of these experiences can help him figure out if (and how) the problem-solving processes and outcomes can be reused, or adapted to the current situation.

Two related topics are of interest for providing relevant experiential knowledge for problem solving, namely the case-based reasoning paradigm and lessons learned management. These are in line with the knowledge management vision that expert knowledge (or in general corporate knowledge) should be carefully captured and organized in order to facilitate its subsequent exploitation by knowledge workers. It also relates to the "learning organization" concept that refers to an organization's capability to gain insight and understanding from experience through experimentation, observation, analysis, and a willingness to examine both successes and failures.

6.1. Case-based reasoning

The case-based reasoning (CBR) paradigm [29] is based on the premise that human beings use analogical reasoning or experiential reasoning to learn and solve complex problems. Instead of relying solely on general knowledge of a problem domain, or making associations along generalized relationships between problem descriptors and conclusions, CBR is able to utilize the specific knowledge of previously experienced, concrete problem situations (cases). It is also an approach to incremental, sustained learning, since a new experience is retained each time a problem has been solved, making it immediately available for future problems. Cases usually consist of information about the situation, the solution, results of that solution and key attributes that can be used for quickly searching for similar patterns of attributes. A new problem is solved by retrieving one or more previously experienced cases, reusing the case(s) in one way or another, revising the solution based on reusing a previous case, and retaining the new experience by incorporating it into the existing knowledge-base (case-base). New solutions are generated by retrieving the most relevant cases and adapting them to fit new situations.

One advantage of CBR is that inexperienced people can draw on the knowledge of experienced colleagues to solve their own problems. Thus, the experiential critic that uses CBR can act as a recommender system, or a training tool.

In the military domain, case-based reasoning approach has been exploited for situation assessment, planning or decision aiding. In planning, in particular, it has been used for retrieving and reusing previous plans or plans' elements from previously solved problems (case library).

Battle planner [30], one of the first CBR systems in the military domain, is a case-based retrieval system for battle planning that projects the effects of plans based on experiences stored in a case library. The user can examine among the best-matching cases which cases were successful and which were considered as failures by experts' evaluations, compared to the proposed plan. Cases can be used to criticize and repair plans, the user can perform what-if analyses with the objective to improve an initial solution.

JADE [31] is a planning tool that has been applied to military force deployment in order to retrieve and reuse force modules (FMs) from previous plans whose force capabilities and composition satisfy the current situation.

HICAP [32] is a general purpose planning architecture that integrates a conversational case-based planner NaCoDAE to interactively refine a task into an operational plan. Its application to noncombatant evacuation operations (NEO) is both doctrine and case-driven. Whereas doctrine describes general aspects of planning, experiences from previous operations suggest more detailed information suitable for the current environment.

One of the challenges for building CBR applications is the representation of cases and the identification of features that best characterize them in order to facilitate the retrieval of best-matching cases in a new situation. Traditionally, cases are expressed as a problem description and solution pair. In order to exploit CBR as a critiquing process, cases should encapsulate sufficient information about the context/situation, as well as arguments for the solution proposed, or knowledge about the problem-solving process (e.g. decision choices, and justifications).

6.2. Lessons Learned

In the Command and Control domain, Lessons Learned constitute a fundamental knowledge asset. As part of its traditional culture, military people have continuously reported observations or lessons after operations or exercises. Past operations' lessons convey important experiential knowledge (both about successes and failures) that can be learned, reused or avoided in future similar situations in a way to make the best decisions and undertake the best actions (e.g. preparation of future operations, selecting best course of actions, etc.). A definition provided in [33] states that a lesson is a validated experiential knowledge from a work experience. It represents tacit knowledge, either positive or negative that can be reused (i.e. retrieved and applied during subsequent problem-solving) to improve a targeted organizational process by suggesting a relevant contribution to a work practice.

As an example, The ALDS system (Active Lessons Delivery System) [33] brings lessons to the attention of users when applicable to the user's current decision-making task under similar conditions. A case-based reasoning approach is used to match the context of the current situation with relevant lessons stored in the system. In another military context, the ACPA (Air Campaign Planning Advisor) system [34] includes a corporate memory

containing video-clips in which experts relate their experience that can support users in their tasks through a model-based task tracking system.

Lessons Learned do not provide a solution to a problem to be solved but rather provide relevant elements that may support or impede the reasoning process, thus influencing the outcome.

6.3. Experiential critics

The experiential critic can provide knowledge specific to situations which share certain characteristics with cases already experienced or lessons learned, and which are stored in the system's knowledge base. The exploitation of cases and lessons learned as a knowledge asset aims at drawing both from successes (i.e. what went well) as well as from failures in order not to repeat errors twice. The reuse of this knowledge by a critiquing system aims at making recommendations from a past situation that apply in the current situation.

Experiential critics would provide knowledge which is not part of the doctrine or the usual training of practitioners and which is essentially acquired through experience. For example, important information about the new environments (remote countries with different social, religious and cultural backgrounds) in which the armed forces are brought to operate, can only be transferred to newcomers through the experience of their co-workers. Along this perspective, Davis and Fu [35] have recently proposed to gather culturally specific experiential data from available sources in order to design a cultural decision aid tool.

In unfamiliar situations, experiential critics can use past observations to remind the user of relevant facts and hypotheses that he may have neglected or that he is unaware of. For example, the critic can remind the operator that certain resources will be necessary if the operations have to take place in a specific region. It can draw the attention of the user on factors he may have overlooked or whose importance has been over or under-estimated in the current situation. It can make the user focus on the implications of certain choices or the effects that certain factors may have on the evaluation of other factors. Finally, it can suggest alternatives for certain important assumptions on which later decisions may depend.

As discussed previously, in complex decision-making contexts, individuals employ subjective probabilities based on their degree of belief in the possible outcomes and resort to the use of heuristics. Heuristics allow humans to quickly process huge amounts of information and often arrive at reasonable decisions under difficult circumstances. Using heuristics implies a schema-driven reasoning [36] where the individuals use their prior knowledge and experience in the decision episode domain to make inferences about a situation and decide what information is valuable for the solution. This 'enables speedy assessment, search, selection and interpretation' [8] of information.

Such reasoning, where perceived information fits into an existing schema may be prone to many judgment biases, as we mentioned before. We can speculate that in specific instances, when the decision maker is placed in an unfamiliar environment, the use of heuristics may represent an even more serious source of error. An experiential critic can both remind a decision maker facing a familiar context not to overlook data that are not integrated into his schema of the decision situation, and help a decision maker facing an unfamiliar situation take advantage of his co-workers' knowledge and experience.

The provision of experiential knowledge in an unfamiliar context is aimed at avoiding that the practitioners rely on their own experience. Recent studies have questioned experts' abilities in non-repeated decision tasks [37]. These works have revealed that experience improves decision-making only for well-practiced or anticipated tasks with established procedures, while on the other hand, in unique or unanticipated tasks, experience may actually contribute to poorer decision making. Explanations for this poor decision performance of experts are the rigidity and abstraction of the expert's mental models and his/her complacency and overconfidence.

Within the less stressful context of training, experiential critics can target confirmation and availability biases by presenting similar cases with different decision outcomes, but they can also fill the gaps of missing knowledge, by providing the users with field experience missing from their usual training.

Contrary to critics that look for error occurrences or deviations, these critics would hint at experiential knowledge whenever available. Naturally, the practitioner cannot request for this knowledge if he is unaware that it exists. By providing contextualized access to this type of information, critics reduce the cost of learning and optimize the effort-accuracy trade-off involved in accessing domain knowledge.

However, case-related information must be made available at different levels of detail. For example, the detection of similarities along certain dimensions (e.g. area of operations, type of events, type of threat, etc.) would activate punctual critiques that would be related to those same aspects. Knowing that these critiques are based on cases or lessons learned, the user can decide to obtain more in-depth information by viewing the whole scenario or situation. Thus, the user can proceed to further examination of cases (for example, through hypertext links) in order to contextualize those aspects for which observations, advice, positive or negative critiques are provided. By looking at commonalities and differences of retrieved situations, users analyze the context of these situations, assess if they fit with their understanding of the current situation, and determine to what extent retrieved experiences could apply, and if not why.

The obvious consequence of this process is learning, and the expected one is learning to think critically. The critic does not only provide the user with knowledge of past experiences, helping him learn about relevant criteria and issues, but it also, in the long term, enrols him into the habit of gathering knowledge and considering different perspectives before committing to a decision.

7. Conclusion

In the preceding, we outlined the principles of critical thinking and discussed the ways in which they can be supported by critiquing systems. Critiquing systems do not empower the user with the meta-cognitive capacity of evaluating his own reasoning, but can give him cues which can make him explore new perspectives or seek knowledge.

We discussed the concurrent use of two types of critics, generic critics, which critique the user's solution with respect to doctrine-related knowledge, and experiential critics, which provide relevant information retrieved from past cases and lessons learned. Generic critics can act as cognitive assistants that can help the user manage multiple parameters and apply domain knowledge, but they can also force second thought by questioning the user's position and assumptions. Experiential critics, on the other hand, can draw the user's attention on alternatives he had not foreseen and acquaint him with knowledge he does not possess. These feedbacks enhance the user's understanding of the problem and may either lead him to focus on or to reconsider certain aspects of his solution. The critiquing process can thus improve the quality of the user's decision making by promoting reflection and give him the opportunity to learn.

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Supporting Critical Thinking with Critiquing Systems in Military C2 Environments

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OUTLINE

- Critical thinking: principles
- Critiquing systems
- Dialogue paradigm
- Critiquing process
- Errors and biases
- Critics: knowledge & strategy
  - Generic critics
  - Experiential critics
- Conclusion

Critical Thinking

Critical thinking is the ability to think about one's thinking in such a way as to recognize its strengths and weaknesses and, as a result, to recast the thinking in an improved form.

Needed because of:

- Increasing complexity
- Changing character of military operations
- Information overload
- Increased responsibilities

Critical thinking in the military context

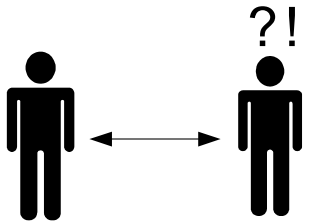
- Asking questions
- Clearly defining the problem
- Seeking & examining evidence
- Closely examining reasoning and assumptions
- Analyzing basic concepts
- Avoiding oversimplification
- Considering alternative viewpoints
- Tracing out implications and consequences

Critiquing systems

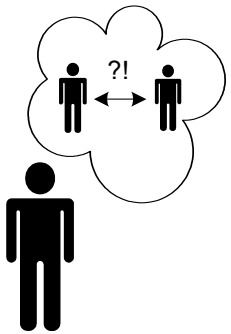
- A class of program that receive as input the statement of the problem and the user-proposed solution and produce as output a critique of the user's judgment and knowledge.
- Feedback to user:
  - Report errors
  - Point out incompleteness
  - Suggest alternatives
  - Offer heuristic advice

Dialogue paradigm

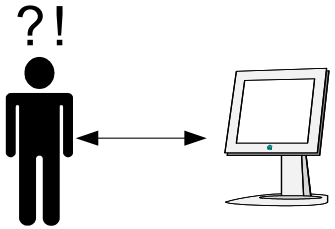
Critical discussion



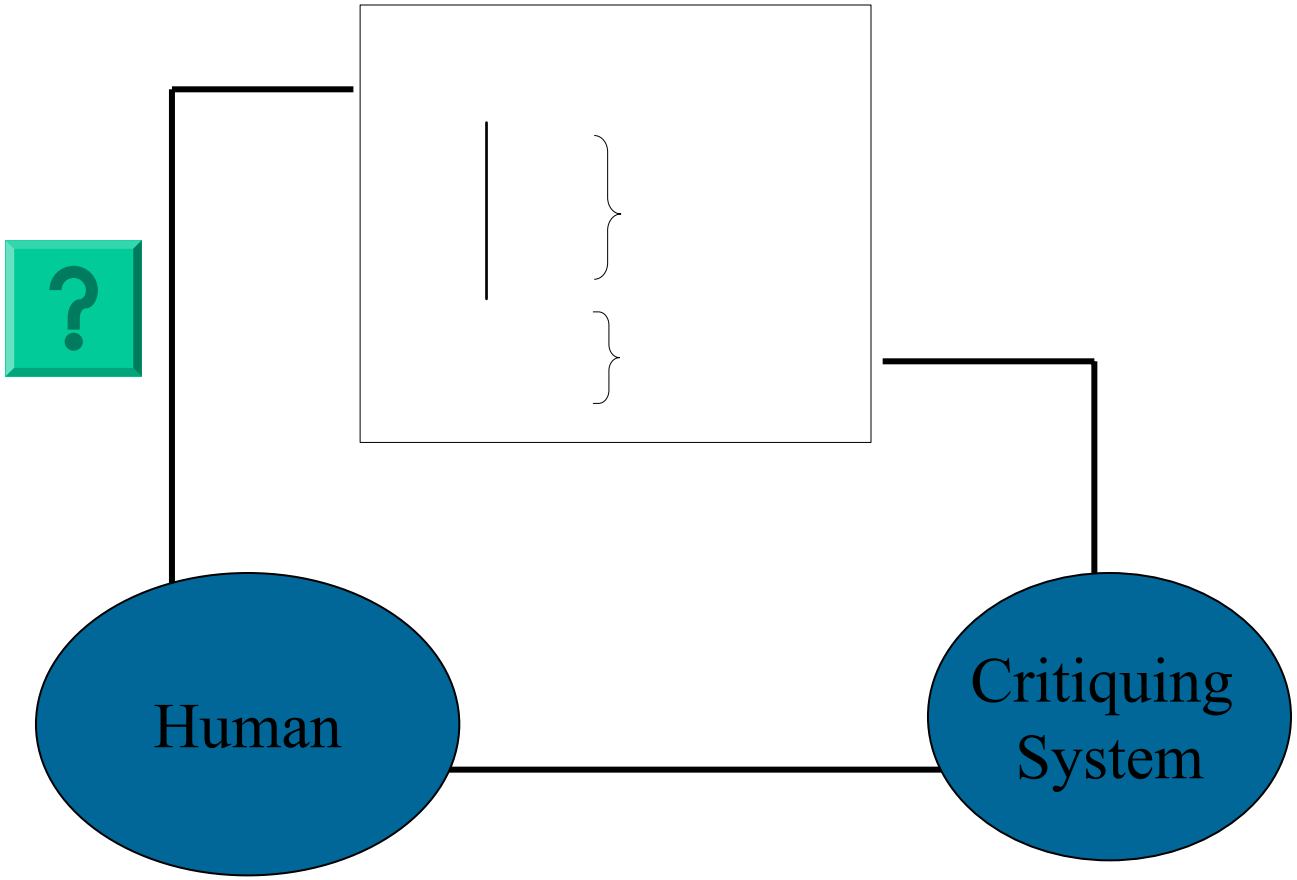
Critical thinking



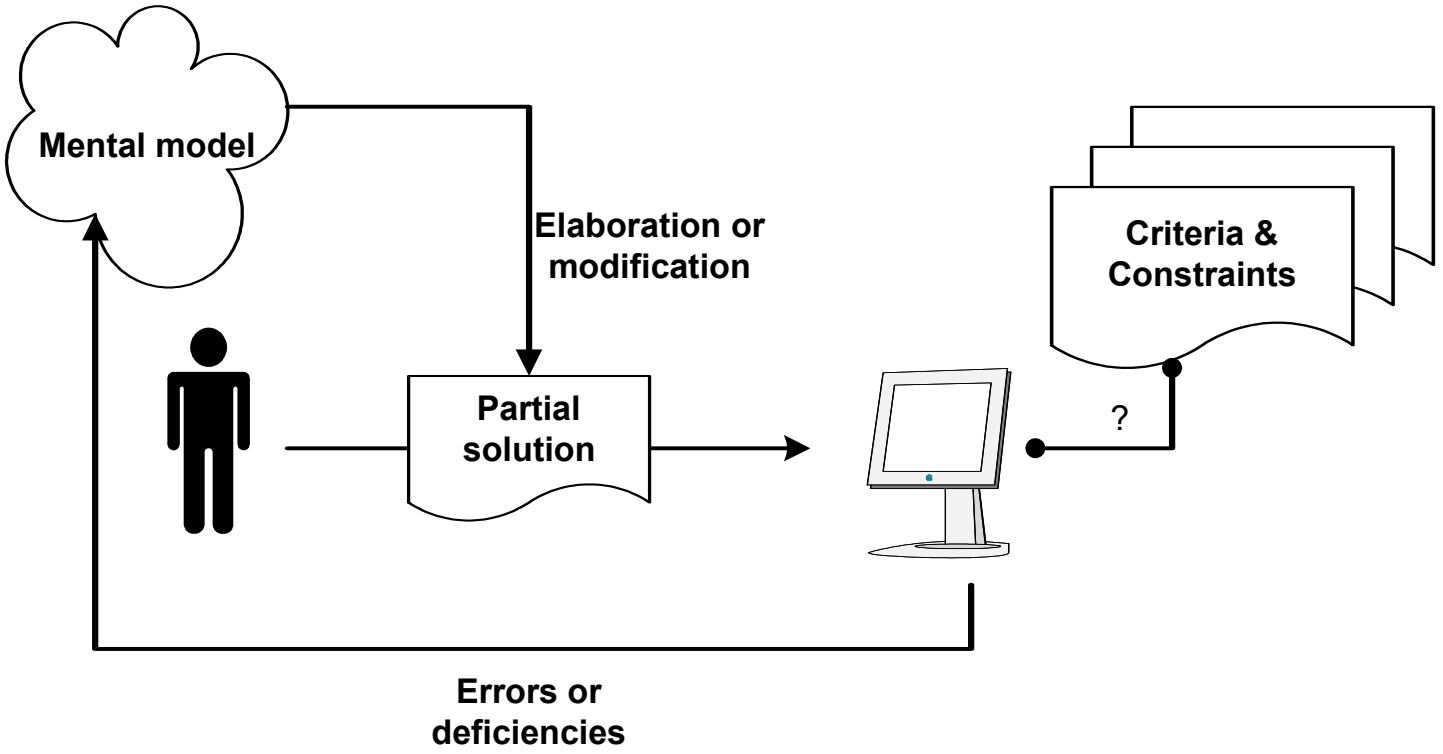
Critiquing systems



Critique versus Evaluation



Critiquing process



Errors & Biases

- Knowledge errors due to missing concept or missing knowledge
- Errors in reasoning processes due to cognitive bias or systematic selection of poor judgment heuristics
  - Force of habit
  - Selective perception
  - Availability bias
  - Confirmation bias: seeking information consistent with current beliefs and avoiding falsifying evidence.

Overlooked and/or missing knowledge

Critic can provide (in training sessions):

- Doctrine-related knowledge that the practitioner ‘normally masters but has neglected to apply’.

- Experiential knowledge that is based on other individuals’ experiences and observations and which are either unknown or not accessible to the user.

Generic critics

- Provide general knowledge about standard practices
- Remind certain rules, criteria, constraints
- Check whether procedures have been followed & requirements have been met

Constraint-satisfaction problem-solving

- Manage multiple factors (procedures, risks, benefits, side-effects, cost)
- Check for inconsistencies and problematic conditions
- Check whether alternative solutions have been considered

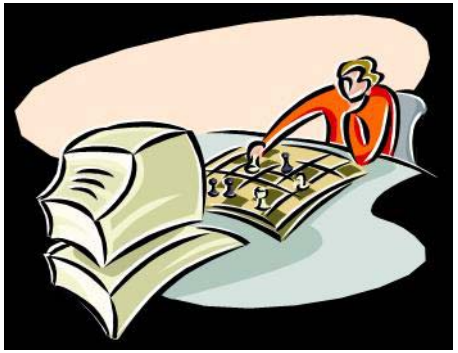
Generic critics: strategies

Leading Question Asking, Explaining, Arguing

- Problem has been correctly identified
- Right objectives
- Objectives have been clearly articulated
- All options have been considered
- Relevant criteria
- Undesired consequences
- Valid assumptions
- Correct inferences

Human-system criticism dialogues in a training context

- Different problem solving approaches
- Tolerance to system-generated critiques
- Tolerance to intrusiveness
- Openness to different perspectives
- Evaluation of data independently from personal goals and beliefs



Experiential critics

- Relate past experiences and observations to the current problem-solving situation.
- Make the user regress to distributional data (knowledge about distribution of outcomes in similar situations)

Case-based reasoning &
Lessons learned management

- Capture and organization of knowledge for future use
- An approach to incremental, sustained learning

Case-Based Reasoning

- Supports analogical reasoning.
- Use of specific knowledge of previously experienced, concrete problem situations as opposed to making associations along generalized relationships.
- Detailed information that can support inexperienced individuals.
- Constitutes corporate memory.

Lessons Learned

- Lesson: ‘A validated experiential knowledge from a work experience.’
- Tacit knowledge that can be reused to improve a process by suggesting a relevant contribution to a work practice.
- Allows evaluation of both successes and failures.
- Not solutions to problems but relevant elements that may support or impede a reasoning process.

Experiential critics: strategies

- Critic uses knowledge assets (CBR, LL) to make recommendations proactively.
- Acquaint the practitioner with knowledge he is unaware of.

Provide knowledge at different levels of description.

  - Critic hints at information based on detected similarities (area of operation, type of threat, etc.).
  - User proceeds to further examination of cases, thus contextualizing advice, observation, positive or negative critiques.
  - User determines to what extent retrieved experience can apply.

Experiential critics

- Provide specific knowledge that can only be acquired through the experience of co-workers (e,g. information about remote countries with different social, religious and cultural backgrounds).

Experiential critics

- Avoid use of heuristics (schema-driven reasoning) in unfamiliar situations.

1. Familiar situation: Not to overlook data that are not integrated into his schema of decision situation.
2. Unfamiliar situation: Take advantage of his co-workers' knowledge and experience.

(Personal experience improves decision-making only for well-practiced or anticipated tasks with established procedures)

Experiential critics

- Operate both on errors of knowledge and errors of reasoning.
  - Target confirmation bias and availability biases (similar situations but different outcomes)
  - Fill the gaps of knowledge (missing from usual training)
- Reduce cost of learning
- Learn to think critically

Conclusion

- Provide ‘unsuspected’ knowledge;
- Make the user consider relevant criteria & issues;
- Make the user question position and assumptions;
- Draw the user’s attention on alternatives he had not foreseen;
- Promote reflection & create learning opportunities;
- Enroll the practitioner into the habit of gathering data and considering different perspectives before committing to a decision.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